

in the Figures. Support for the amendment to the claims is found in the original claims. No new matter is believed to be introduced by the above amendment.

REMARKS

Claims 1, 9, 25, and 28 are canceled. Claims 2-8, 10-24, 26-27, and 29-31 are pending. Favorable reconsideration is respectfully requested.

At the outset, Applicants thank Examiner Medina Sanabria for the courteous and helpful discussion of the present application held on December 4, 2002, and for indicating that the amendment above, combined with the remarks below and the enclosed 132 Declaration, would favorably advance prosecution of the present application.

The rejection of Claims 1-4, 6-7, 10-14, 16, 17-20, 22-23, 26-27, and 30-31 under 35 U.S.C. § 102(b) over Igarashi is believed to be obviated by the above amendment. Claims 1, 9, 25, and 28 are canceled. As the Office indicates, Igarashi fails to disclose the specific embodiments of Claims 9 and 25. The above amendment incorporates the specific embodiments of Claims 9 and 25 into the independent claims (See amended claims above). Therefore, Igarashi fails to disclose the claimed invention. Accordingly, withdrawal of this ground of rejection is respectfully requested.

The rejection of Claims 1-5, 7, 10, 12-14, 16-21, 23, 26, and 30-31 under 35 U.S.C. § 102(b) over Uchiyama et al. is believed to be obviated by the above amendment. Claims 1, 9, 25, and 28 are canceled. As the Office indicates, Uchiyama et al. fails to disclose the specific embodiments of Claim 2 and 9. The above amendment incorporates the specific embodiment of Claims 9 and 25 into the independent claims (See amended claims above). Therefore, Uchiyama et al. fails to disclose the claimed invention. Accordingly, withdrawal of this ground of rejection is respectfully requested.

The rejections of Claims 8, 9, 15, 24, 25, and 28-29 under 35 U.S.C. § 103(a) over any combination of Igarashi, Uchiyama et al., and/or Olsen et al. is believed to be obviated by the above amendment. Claims 9 and 25 are canceled.

Igarashi, at best, discloses a catalyst that may contain zirconium. However, Igarashi fails to appreciate that the amount of zirconium impacts the catalytic properties of the a catalyst containing the same. According, Igarashi fails to disclose with any appreciable specificity, any amounts of the zirconium content in any Examples whatsoever, much less the impact of such amounts on the relative catalytic properties of the resultant catalysts.

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Olsen et al., at best, disclose a method of reforming hydrocarbons by using a catalyst that may contain ruthenium and carbon dioxide. There appears to be no mention of zirconium in the catalyst according to Olsen et al. whatsoever, much less specific amounts of zirconium or the impact of such amounts on the relative catalytic properties of the resultant catalysts.

In direct contrast, the claimed invention relates to a catalyst containing an inorganic oxide carrier containing from 0.05 to 20 wt.% zirconium as reduced to ZrO_2 and ruthenium. The present invention also relates to various methods of using the above catalyst.

A catalyst containing an inorganic oxide carrier containing from 0.05 to 20 wt.% zirconium is superior to catalysts containing zirconium in amounts outside this range. In support of this, Applicants respectfully submit the 132 Declaration attached hereto.

The Declaration provides descriptions of 5 compositions that are similar to that disclosed in Example 4 of the present specification, as well as Example 4 again. The differences in the catalysts lie in the amounts of zirconium oxychloride utilized therein each. See Table A at page 2 of the Declaration to see amounts of zirconium in each catalyst, e.g. compositions 1-6. For the Examiner's convenience, Example 4 is indicated with double asterisk (i.e. **). Please note that compositions 1 and 6 contain zirconium in amounts outside the claimed range (composition 1 contains 0% zirconium and composition 6 contains 24% zirconium).

The Declaration contains information on the catalytic characteristics of each catalyst when utilized in an autothermal reforming reaction (see Table B in the Declaration at page 2). The characteristics are measured during an autothermal reforming reaction that is the same as that disclosed by Example 4 in the present specification. It is clear that those catalysts containing zirconium in amounts within the claimed ranges possess a higher rate of hydrocarbon conversion (HC conversion) than those catalysts that do not. More specifically, the average HC conversion of those claimed catalysts is 88%, while those compositions containing zirconium falling outside the claimed range have an average HC conversion of 79.3. Therefore, on average, the claimed catalysts containing zirconium within the claimed ranges are about 10% more efficient than those catalysts containing zirconium in amounts falling outside the claimed range. At the same time, only a small amount of coke is deposited on the claimed catalysts after the autothermal reforming reaction for 10 hours (0.1).

Additionally, the Declaration contains information on the catalytic characteristics of each catalyst when utilized in an reforming reaction with carbon dioxide (see Table C in the Declaration at page 3). The characteristics are measured during a reforming reaction with carbon dioxide that is the same as that disclosed by Example 9 in the present specification. It is clear that those catalysts containing zirconium in amounts within the claimed ranges generate a higher

yield of CO than those compositions that do not. More specifically, the average CO yield of the claimed compositions is 83.2% after one hour and 81.5% after 10 hours, while those compositions containing zirconium in amounts falling outside the claimed range have an average CO yield of 76.5 after one hour and 71% after 10 hours. Therefore, on average, the claimed catalysts containing zirconium within the claimed ranges yield about 8% more CO than those catalysts containing zirconium in amounts falling outside the claimed range. At the same time, there exists only a minute, e.g. less than 2%, decrease in the yield after 10 hours compared to 1 hour of the reaction for catalysts containing zirconium within the claimed ranges, while there is over a 5% reduction in the yield after 10 hours compared to 1 hour of the reaction for catalysts containing zirconium in amounts falling outside the claimed range.

In light of the above, Applicants respectfully submit that the results presented in the enclosed 132 Declaration clearly demonstrate the superior catalytic properties of the claimed catalysts containing zirconium within the claimed ranges compared to those catalysts containing zirconium in amounts falling outside the claimed range. Since all of the above-mentioned references fail to disclose with any appreciable specificity, any amounts of the zirconium content in any Examples whatsoever, much less the impact of such amounts on the relative catalytic properties of the resultant catalysts, Igarashi, Uchiyama et al., and/or Olsen et al. fail to disclose or suggest the claimed invention, much less recognize this aspect of the claimed invention. Accordingly, withdrawal of these grounds of rejection is respectfully requested.

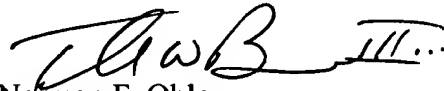
The rejections of Claims 12-31 under 35 U.S.C. § 112, second paragraph, and/or 35 U.S.C. § 101 are obviated by the above amendment. More specifically, Claim 12-24, 26-27, and 29-31 has been amended to include a positive method/process step. Further, Claims 25 and 28 are canceled. Accordingly, withdrawal of these grounds of rejection is respectfully requested.

Finally, the objection to the Drawings is believed to be obviated by the amendment above. The specification has been amended in accordance with the Examiner's suggestion to add reference signs utilized in the Figures.

Applicants respectfully submit that the present application is now in condition for allowance. Early notice to this effect is respectfully requested. Should anything further be required to place this application in condition for allowance, the Examiner is requested the undersigned by telephone.

Respectfully submitted,

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Serial No: 09/701,585

Amendment Filed on:

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IN THE SPECIFICATION

Please replace the paragraph beginning at page 29, line 7, with the following paragraph.

--An autothermal reforming process of natural gas using a fixed-bed reactor is illustrated in Fig. 1. The same process can be used for autothermal reforming of naphtha or LPG. First, natural gas is desulfurized in a desulfurization unit 10, to thereby remove sulfur. The feedstock is typically hydrodesulfurized in the desulfurization unit 10, and the produced hydrogen sulfide therein is washed for removal. In this case, a substance absorbing hydrogen sulfide, such as zinc oxide, may be placed into the bottom layer of catalyst layer, to thereby remove hydrogen sulfide. Subsequently, a mixture gas 7 which is formed by adding steam 2, oxygen 3, and optional carbon dioxide to the desulfurized natural gas 6 from which hydrogen is not typically separated is introduced into an autothermal reforming reactor 11. The natural gas is autothermally reformed, e.g. partially oxidized and reformed, to thereby obtain an impure synthesis gas 8. The synthesis gas 8 is processed at a carbon dioxide-separator 16 and at an excessive-hydrogen-separator 17, to thereby obtain a synthesis gas having a desired ratio of hydrogen/carbon monoxide 9. The carbon dioxide 4 separated at the carbon dioxide-separator 16 may be again introduced into the autothermal reforming reactor 11. The hydrogen 5 separated at the excessive-hydrogen-separator 17 may be used, to thereby desulfurize the natural gas serving as a feedstock. Further, the carbon dioxide-separator 16 and the hydrogen-separator 17 may be omitted by adjusting amounts of oxygen, steam, and carbon dioxide.--

IN THE CLAIMS

Please amend the claims as follows.

--2. (Amended) [An autothermal reforming] A catalyst, comprising an inorganic oxide carrier [carrying] wherein the inorganic oxide carrier comprises from 0.05 to 20 wt.% zirconium as reduced to ZrO₂ and ruthenium.

3. (Twice Amended) [An] The [autothermal reforming] catalyst according to claim [1] 2, [which contains] comprising from 0.05 to 20 wt.% ruthenium [in an amount of 0.05-20 wt%].

4. (Twice Amended) [An] The [autothermal reforming] catalyst according to claim [1] 2, wherein the catalyst further [contains] comprises at least one member selected from the group consisting of cobalt [and/or] and magnesium.

5. (Amended) [An] The [autothermal reforming] catalyst according to claim 4, wherein the cobalt content is from 0.01[-] to 30 based on atomic ratio of cobalt to ruthenium.

6. (Twice Amended) [An] The [autothermal reforming] catalyst according to claim 4, wherein the magnesium content is from 0.5[-] to 20 wt.% as reduced to MgO.

7. (Twice Amended) [An] The [autothermal reforming] catalyst according to claim 2, wherein the inorganic oxide carrier [is formed of] further comprises alumina.

8. (Amended) [An] The [autothermal reforming] catalyst according to claim 7, wherein the alumina is at least one member selected from the group consisting of α -alumina [or] and γ -alumina.

10. (Twice Amended) A method for producing [an autothermal reforming] the catalyst as described in claim [1] 2, [which method comprises] comprising [incorporating] contacting a solution [containing] comprising ruthenium, a solution [containing] comprising ruthenium and cobalt, or a solution [containing] comprising ruthenium, cobalt and magnesium [into] with a zirconia carrier; [and] drying the carrier; and calcining the carrier.

11. (Twice Amended) A method for producing [an autothermal reforming] the catalyst as described in] according to claim 2, [which method comprises] comprising [incorporating] contacting a solution [containing] comprising zirconium and ruthenium, a solution [containing] comprising zirconium, ruthenium, and cobalt, or a solution [containing] comprising zirconium, ruthenium, cobalt, and magnesium [into] with an inorganic oxide carrier; [and] drying the carrier; and calcining the carrier.

12. (Twice Amended) A method for producing hydrogen or a synthesis gas, [by use of an autothermal reforming catalyst as described in claim 1] comprising contacting an organic compound and a reforming gas with a catalyst wherein the catalyst comprises an inorganic oxide carrier wherein the inorganic oxide carrier comprises from 0.05 to 20 wt.% zirconium as reduced to ZrO_2 and ruthenium.

13. (Amended) [A] The method [for producing hydrogen or a synthesis gas] according to claim 12, [wherein] further comprising contacting the catalyst with a starting material for producing hydrogen or a synthesis gas wherein the starting material is a hydrocarbon.

14. (Amended) [A] The method [for producing hydrogen or a synthesis gas] according to claim 13, wherein the hydrocarbon is at least one member selected from the group consisting of methane, liquefied petroleum gas, naphtha, kerosene, [or] and gas oil

15. (Twice Amended) [A] The method [for producing hydrogen or a synthesis gas] according to claim 12, further comprising contacting the catalyst with a feedstock wherein [a] the feedstock [for producing hydrogen or a synthesis gas is] comprises at least one member selected from the group consisting of methanol, ethanol, [or] and dimethyl ether.

16. (Twice Amended) [A] The method [for producing hydrogen or a synthesis gas] according to claim 12, wherein [a] the reforming gas comprises a mixture of oxygen, steam, and carbon dioxide.

17. (Amended) A [catalyst for reforming hydrocarbon by use of carbon dioxide] method for reforming hydrocarbon, [which comprises] comprising contacting carbon dioxide gas with a catalyst comprising a zirconia carrier [carrying] and ruthenium to produce a resultant mixture; and reforming hydrocarbon with the resultant mixture.

18. (Amended) A [catalyst for reforming hydrocarbon by use of carbon dioxide] method for reforming hydrocarbon, [which comprises] comprising contacting carbon dioxide

gas with a catalyst comprising an inorganic oxide carrier, from 0.05 to 20 wt.% [carrying] zirconium as reduced to ZrO_2 , and ruthenium to produce a resultant mixture; and reforming hydrocarbon with the resultant mixture

19. (Twice Amended) [A catalyst] The method [for reforming hydrocarbon] according to claim 17, [which contains] wherein the ruthenium is present in an amount of from 0.05[-] to 20 wt.%.

20. (Twice Amended) [A] The method [for reforming hydrocarbon] according to claim 17, [which] wherein the catalyst further [contains] comprises at least one member selected from the group consisting of cobalt [and/or] and magnesium.

21. (Amended) [A] The method [for reforming hydrocarbon] according to claim 20, wherein the cobalt content is from 0.01[-] to 30 based on the atomic ratio of cobalt to ruthenium.

22. (Twice Amended) [A catalyst] The method [for reforming hydrocarbon] according to claim 20, wherein the magnesium content is from 0.5[-] to 20 wt.% as reduced to MgO.

23. (Twice Amended) [A catalyst] The method [for reforming hydrocarbon] according to claim 18, wherein the inorganic oxide carrier [is formed of] comprises alumina.

24. (Amended) [A catalyst] The method [for reforming hydrocarbon] according to claim 23, wherein the alumina is at least one member selected from the group consisting of α -alumina [or] γ -alumina.

26. (Twice Amended) [A] The method [for producing a catalyst for reforming hydrocarbon] as described in claim 17, [which method comprises incorporating] further comprising contacting a solution [containing] comprising ruthenium, a solution [containing] comprising ruthenium and cobalt, or a solution [containing] comprising ruthenium, cobalt and magnesium [into] with a zirconia carrier; [and] drying the carrier; and calcining the carrier.

27. (Amended) [A] The method [for producing a catalyst for reforming hydrocarbon] as described in claim 18, [which method comprises] further comprising [incorporating] contacting a solution [containing] comprising zirconium, a solution [containing] comprising zirconium and ruthenium, a solution [containing] comprising zirconium, ruthenium, and cobalt, or a solution [containing] comprising zirconium, ruthenium, cobalt, and magnesium [into] with an inorganic oxide carrier; [and] drying the carrier; and calcining the carrier.

29. (Amended) [A] The method according to claim [28] 17, wherein the hydrocarbon is methane.

30. (Amended) A method for reforming natural gas, comprising contacting natural gas with the catalyst according to Claim 2 [by use of a catalyst for reforming hydrocarbon as described in claim 17].--

--Claims 1, 9, 25, and 28 are canceled.--